WASHINGTON STATE DEPARTMENT OF
Natural Resources
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This document is part of a collection of [Ecological Integrity Assessments] addressing 67 of Washington's 99 [Ecological Systems]. These documents were prepared by the Washington Natural Heritage Program with funding provided by the Washington Department of Fish and Wildlife.

Ecological Integrity Assessment: Columbia Plateau Vernal Pool and Modoc Basalt Flow Vernal Pool

Ecological Summary

The Columbia Plateau Vernal Pool small patch system occurs throughout the exposed volcanic scablands on the Columbia Plateau in Washington, Oregon, and northern Nevada. Washington occurrences are concentrated in the Channeled Scablands and glaciated areas in Spokane, Lincoln, Douglas, southern Okanogan, Grant, Whitman and Adams counties. They are often found within a mounded or biscuit-swale topography within *Artemisia* shrub-steppe, bunchgrass steppe or rarely *Pinus ponderosa* savanna. They are characterized by freshwater inundation for much of the winter and spring, followed by dramatic lowering of the water table at the approach of summer, such that soils are dry in the summer. They are found in isolated small depressions with no inflow or outflow and a restrictive subsurface soil layer (clay or bedrock). Vegetation is dominated primarily by annual forbs. This EIA also applies to the **Modoc Basalt Flow Vernal Pool** ecological system found on exposed basalt along the Columbia River Gorge in Klickitat County, Washington.

The Columbia Plateau Vernal Pool system occurs as shallow ephemeral wetlands in very small (3 square meters or 32 sq. ft.) to rarely large depressions (260 ha or 1 square mile). Bjork and Dunwiddie (2004) measured 242 vernal pools in Washington to be between 3 sq m. and 4610 sq. m. (1.1 ac) with a 1590 sq. m (0.4 acre) average. Vernal pools mostly are located on massive basalt flows exposed by Pleistocene floods but also occur on andesite or rhyodacite caprock. Often perched above the surrounding landscape, vernal pools are generally not subject to runoff from major stream systems. Climatically, the system is defined by wet winters (November through January) and severe summer drought (July-September), although May or June can be wet. Pool inundation primarily results from direct precipitation and varies yearly and seasonally, and with the size of the small upland watershed associated with a vernal pool or in some cases, surface runoff from adjacent pools or wetlands (Environmental Science Associates 2007). Inundation is highly irregular, sometimes not occurring for several years. Depressions usually (but not always) fill with water during winter and spring and generally dry well within 9 months. In exceptional times they can remain inundated for two consecutive years. Soil texture is typically silty clay, sometimes with sandy margins.

The periodic inundation and drying leads to development of concentric zones of different plants as the pools dries (Crowe and other 1994). Characteristic plants species of this system are predominantly annual and diverse. Floristically this system is akin to the California vernal pool flora (approximately one-third); however, many of the most abundant species are not reported in Californian pools (Bjork and Dunwiddie 2004). Characteristic species include *Callitriche marginata, Camissonia tanacetifolia, Elatine* spp., *Epilobium densiflorum (= Boisduvalia densiflora), Eryngium vaseyi, Juncus uncialis, Myosurus X clavicaulis, Plagiobothrys* spp., *Polygonum polygaloides* ssp. *confertiflorum, Polygonum polygaloides* ssp. *polygaloides, Psilocarphus brevissimus, Psilocarphus elatior, Psilocarphus oregonus*, and *Trifolium cyathiferum* (Bjork 1997; Bjork and Dunwiddie 2004). *Artemisia ludoviciana* ssp. *ludoviciana* can occur on better developed soils. When full, the pool's water column and saturated substrates support assemblages of macroinvertebrates as well as habitat for mobile invertebrates adapted to ephemeral wetlands (Environmental Science Associates 2007). Fairy shrimps (Anostraca) are found in vernal pools along with birds and amphibians (Environmental Science Associates 2007). Pools provide water storage and support nitrogen transformation (Environmental Science Associates 2007).

Biogeographic differences separate this system from the Modoc Basalt Flow Vernal Pool and geography and soil type/parent material from the North Pacific Hardpan Vernal Pool. Annual plant dominance and lack of surface salt deposits distinguish the Columbia Plateau Vernal Pool from the Inter-Mountain Basin Alkaline Closed Depression.

Stressors

The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

Historic and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of vernal pools on the Columbia Basin. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can also have a substantial impact on the hydrological regime. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roading or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. In general, excessive livestock use leads to a shift in plant species composition. Several exotic species can invade this habitat with grazing or other soil disturbance. Native species, such as *Juncus bufonis* and *Polygonum aviculare* increase with excessive livestock use and *Eleocharis* spp. decrease (Brown 2001). Vernal pool invasibility depends on multiple biotic and physical factors including hydrologic regime, soil nutrient properties, the native plant community, site disturbance history and climatic variability (Environmental Science Associates 2007). Southern Oregon vernal pools showed a pattern noted in California vernal pools of non-native plant species occurring in higher abundance in the outer edge or "flank" zone of pools (Environmental Science Associates 2007). Invasion likely occurs as an indirect result of the prevalence of non-native upland plants in the surrounding uplands (Environmental Science Associates 2007). Zedler (1987) stated that "moderate cattle or horse grazing does not seem to pose much of a threat to the persistence of vernal pool plants despite the disruptive effect of trampling". Brown (2001) following a 2-year study in eastern Washington found a significantly greater cover of "weedy species" in grazed vernal pools. Grazing livestock has been experimentally correlated with a significantly longer duration of vernal pool hydrology during dry-down stage, in comparison to ungrazed pools ((Environmental Science Associates 2007).

Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Several exotic species invade vernal pools particularly upper zones: *Centaurea spp.*, *Cirsium arvense*, *Descurainia sophia*, *Elytrigia repens*, *Phalaris arundinacea*, *Poa compressa*, *Poa pratensis*, and *Sisymbrium altissimum* (Bjork and Dunwiddie 2004). Although most wetlands receive regulatory protection at the national, state, and county level, many wetlands have been and continued to be filled, drained, grazed, and farmed extensively. Even minor changes in the water table depth or duration of inundation can have profound effects on soil salinity, and consequently, wetland vegetation (Cooper and Severn 1992). Wetland animals, such as waterbirds, amphibians, or invertebrates are affected changes in hydrology.

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with this system are presented in Figure 1.

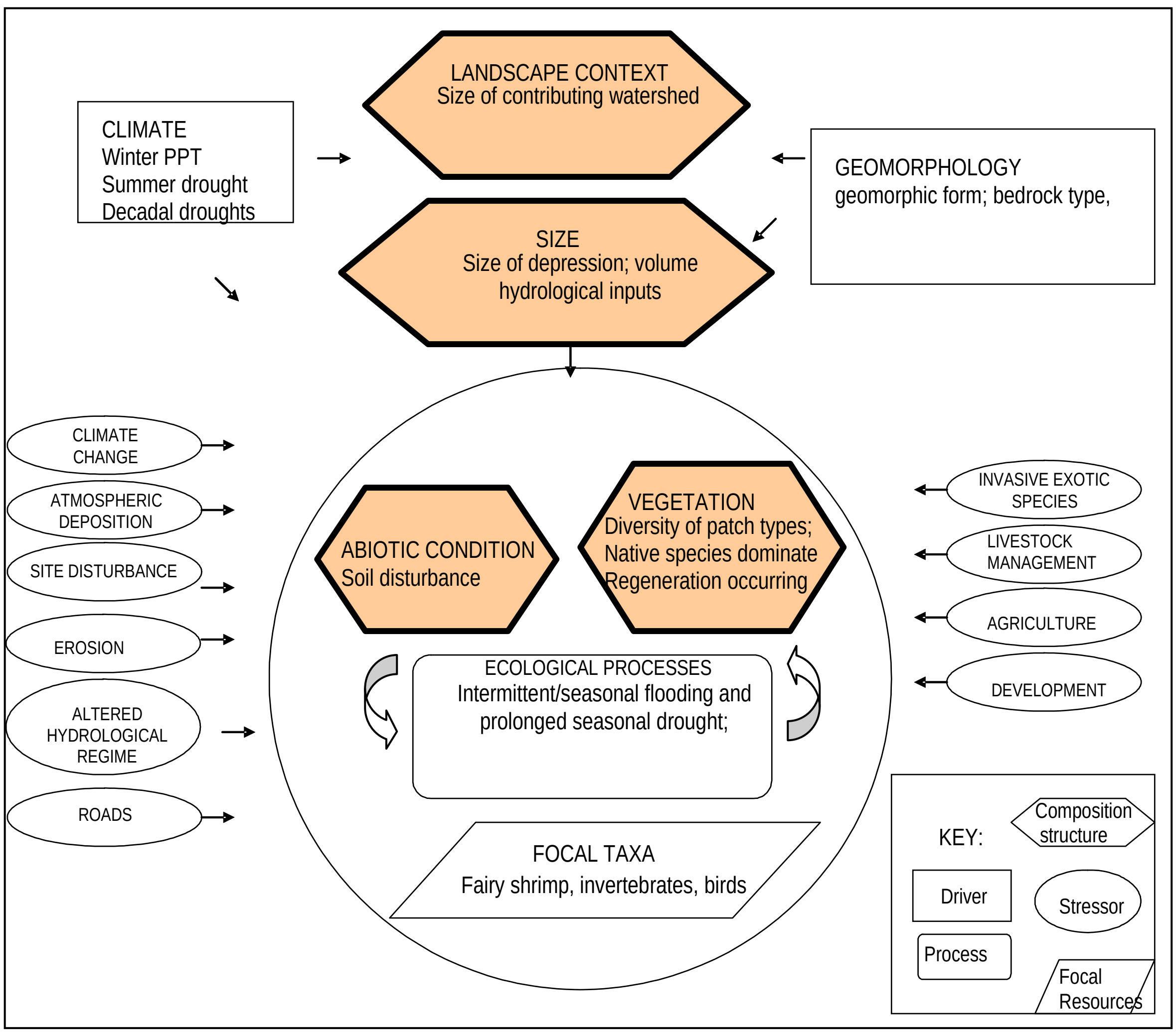

Figure 1. Conceptual Ecological Model for Columbia Plateau Vernal Pool Ecological System

Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system.

Level 2 EIA

The following tables display the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas. **Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 1. Columbia Plateau Vernal Pool ecological System Level 2 EIA.

Metric	Justification	Rank			
		A (5 pts.)	**B (4 pts.)**	**C (3 pts.)**	**D (1 pts.)**
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Buffer*					
Buffer Length	The buffer can be important to biotic and abiotic aspects of the wetland. Buffer Width Slope Multiplier 5-14% -->1.3; 15-40%-->1.4; >40%-->1.5	Buffer is > 75 – 100% of occurrence perimeter.	Buffer is > 50 – 74% of occurrence perimeter.	Buffer is 25 – 49% of occurrence perimeter	Buffer is < 25% of occurrence perimeter.
Buffer Width		Average buffer width of occurrence is > 200 m, adjusted for slope.	Average buffer width is 100 – 199 m, after adjusting for slope.	Average buffer width is 50 – 99 m, after adjusting for slope.	Average buffer width is < 49 m, after adjusting for slope.
Buffer Condition		Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND little or no trash or refuse.	Substantial (75–95%) cover of native vegetation, low (5–25%) cover of non-native plants, intact or moderately disrupted soils; minor intensity of human visitation or recreation.	Moderate (25–50%) cover of non-native plants, moderate or extensive soil disruption; moderate intensity of human visitation or recreation.	Dominant (>50%) cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils, moderate or greater intensity of human visitation or recreation, no buffer at all.
Key Ecological Attribute: *Landscape Structure*					

Connectivity	The percentage of anthropogenic (altered) patches provides an estimate of connectivity among natural ecological systems within 150 m (500 ft) (Environmental Science Associates 2007).	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high. (Remaining natural habitat is in good condition (low modification); and a mosaic with gradients).	Variegated: Embedded in 60-90% natural habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification; (Remaining natural habitat with low to high modification and a mosaic that may have both gradients and abrupt boundaries).	Fragmented: Embedded in 10-60% natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape. (Remaining natural habitat with low to high modifications and gradients shortened).	Relictual: Embedded in < 10% natural habitat; connectivity is essentially absent. Remaining natural habitat generally highly modified and generally uniform).
Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index > 0.8		Landscape Condition Model Index 0.65 – 0.79	Landscape Condition Model Index < 0.65
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation*					
Relative Cover Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Cover of native plants 95-100%.	Cover of native plants 80-95%.	Cover of native plants 50 to 79%.	Cover of native plants <50%.
Absolute Cover of Exotic Invasive Species	Invasive species can inflict a wide range of ecological impacts. Early detection is critical. *Cirsium arvense, Elytrigia repens* and *Taeniatherum caput-medusae* are examples.	None present.	Invasive species present, but sporadic (<3% cover).	Invasive species prevalent (3–10% absolute cover).	Invasive species abundant (>10% absolute cover).
Relative Cover of Upland Exotic Invasive Species	Invasive species can inflict a wide range of ecological impacts. Early detection is critical. *Apera interrupta,* annual *Bromus, Hypericum perforatum, Lactuca serriola, Poa bulbosa, Sisymbrium altissimum, and Taeniatherum caput-medusae* (Environmental Science Associates 2007).	None present.	Invasive species present, but sporadic (1-50% relative cover) Litter thatch <65%.	Invasive species prevalent (51-75% relative cover). Litter thatch 65-80%.	Invasive species abundant (>75%% relative cover). Litter thatch >80%.

Species Composition Note: Once developed, the Floristic Quality Assessment index could be used here instead.	The overall composition of native species can shift when exposed to stressors.	Species diversity/abundance at or near reference standard conditions. Native species sensitive to anthropogenic degradation are present, functional groups indicative of anthropogenic disturbance (ruderal or "weedy" species) are absent to minor, and full range of diagnostic / indicator species are present.	Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	Species diversity/abundance is different from reference standard condition in, but still largely composed of native species characteristic of the type. This may include ruderal ("weedy") species. Many indicator/diagnostic species may be absent.	Vegetation severely altered from reference standard. Expected strata are absent or dominated by ruderal ("weedy") species, or comprised of planted stands of non-characteristic species, or unnaturally dominated by a single species. Most or all indicator/diagnostic species are absent.
Key Ecological Attribute: *Hydrology*					
Water Source	Anthropogenic sources of water can have detrimental effects on the hydrological regime	Source is natural or naturally lacks water in the growing season. No indication of direct artificial water sources	Source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources	Source is primarily urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology	Water flow has been substantially diminished by human activity
Hydroperiod	Alteration in hydrology or sediment loads or some onsite stressors can degrade depression	Hydroperiod of the site is characterized by natural patterns of filling or inundation and drying or drawdown.	The filling or inundation patterns in the site are of greater magnitude (and greater or lesser duration than would be expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	The filling or inundation patterns in the site are characterized by natural conditions, but thereafter are subject to more rapid or extreme drawdown or drying, as compared to more natural wetlands. OR filling or inundation patterns are of substantially lower magnitude or duration than expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	Both the filling/inundation and drawdown/drying of the site deviate from natural conditions (either increased or decreased in magnitude and/or duration).
Hydrological Alterations	The degree to which onsite or adjacent land uses and human activities have altered hydrological processes. (Environmental Science Associates 2007)	No alterations of vernal pool complex or watershed. No dikes, diversions, ditches, flow additions, or fill present in wetland that restricts or redirects flow	Low intensity alteration such as roads at/near grade, small diversion or ditches (< 1 ft. deep) or small amount of flow additions. 1-20% of vernal pool complex or watershed altered.	Moderate intensity alteration such as 2-lane road, low dikes, roads w/culverts adequate for stream flow, medium diversion or ditches (1-3 ft. deep) or moderate flow additions. 21-60% of vernal pool complex or watershed	High intensity alteration such as 4-lane Hwy., large dikes, diversions, or ditches (>3 ft. deep) capable to lowering water table, large amount of fill, or artificial groundwater pumping or high amounts of flow additions . Over 60% of vernal pool complex or watershed
Key Ecological Attribute: *Physicochemical*					

Soil Surface Condition	Soil disturbance can result in erosion thereby negatively affecting many ecological processes (Environmental Science Associates 2007)	No evidence of soil alteration by anthropogenic sources	Minor degree of soil disturbance, either in intensity or confined to small area (<25%) of vernal pool complex (e.g., low-intensity grazing leaving hoof marks).	Moderate degree of soil disturbance, either in intensity or confined to moderate area of vernal pool complex (<50%)	High degree of soil disturbance, high in intensity and distributed over >50% of complex.
Rank Factor: SIZE					
Key Ecological Attribute: *Size*					
Relative Size	Indicates the proportion lost due to stressors.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)
Absolute Size	Vernal pool complexes of higher acreage (*Area*) are positively correlated with indicators of ecosystem structure that are thought to be highly related to vernal pool ecosystem functioning (Environmental Science Associates 2007) Size range are one standard deviation from mean of eastern channel in Bjork and Dunwiddie (2004)	>180 sq. m (.04 Ac)	180-64 sq. m (0.4-.02 Ac)		<64sq. m. (0.02 ac)

Level 3 EIA
Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, the following metrics should be considered in a Level 3 EIA outline in Rocchio (2006):

- Presence of vernal pool fairy shrimp (Environmental Science Associates 2007)
- Average maximum depth of pool (Environmental Science Associates 2007)
- Percent of watershed containing wetlands (Environmental Science Associates 2007)
- Gopher mounds abundance (Environmental Science Associates 2007)

Triggers or Management Assessment Points
Ecological triggers or conditions under which management activities need to be reassessed are shown in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Table above.

Table 2. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks
If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

Supporting documents for the EIAs can be found at:
http://www1.dnr.wa.gov/nhp/refdesk/communities/eia.html

Documentation about Ecological Systems can be found at:
http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol_systems.html

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February 22, 2011